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FEEDING EXPERIMENTS

INCLUDING

- I. EXPERIMENTS IN FATTENING STOCK FOR BEEF WITH COTTON-SEED HULLS AND MEAL.
 - II. CORN SILAGE AND SOY (SOJA) BEAN SILAGE WITH COTTON-SEED MEAL FOR BEEF.
 - III. EXCLUSIVE ENSILAGE FEEDING, AND WHAT IS A MAINTENANCE RATION.
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N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION, INCLUDING THE FERTILIZER CONTROL STATION AND STATE WEATHER SERVICE,

UNDER THE CONTROL OF THE

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FEEDING EXPERIMENTS.

BY F. E. EMERY, AGRICULTURIST.

The special points investigated and reported in this bulletin are:

1. Feeding experiment to test the relative fattening of steers when loose in roomy stalls, and when tied up in narrow stanchions; all with the same ration of cotton-seed meal and hulls.

2. Relative fattening of native steers and grade steers on the same ration.

3. Relative fattening of two-year-old steers and three-year-old steers.

In connection with these tests the following points are also discussed: (a) What constitutes a good and poor feeder; (b) the time and amount of water drank, and the influence on the apparent live weight; and (c) the water required for different foods.

Other feeding tests are reported as follows:

4. Fattening of steers on corn silage and soy (soja) bean silage, with cotton-seed meal.

5. Exclusive ensilage feeding and the maintenance ration.

The economical use of cheap cattle foods for the production of beef has before* been reported.

The experiments described in the present bulletin are continuations of the same subject, and show that profitable gains of live weight have been made by steers fed on cotton-seed hulls and cotton-seed meal in different proportions. Not only have profitable results been attained by this feeding, but steers were fed which were brought to market for beef by their owners, and consequently were thought sufficiently fat to be sold. This shows two things; that the stock was thought to be ready for market before the real profit in feeding had been realized, and that half-fat beef was being sold. That is, both farmer and butcher were losing profits in their business and consumers were not being supplied with as good beef as could be made at the same price for the better article. This shows a remediable loss to three classes of citizens which we aim to correct. More perfect methods of feeding must necessarily be adopted by the farmer before the steer becomes good beef and produces a better article for butcher and consumer than is usually sent to market.

Aiming toward economy in feeding, only analyzed foods have been used in this work. From these analyses and carefully recorded weights of animals and amounts of food consumed, tables have been calculated showing: (1) The average weights of the steers for each of the twenty-day periods in which they were fed; (2) The actual fresh

* See Bulletin No. 81 of this Station.

weights of food eaten daily; and (3) The total dry matter in the daily food, and its digestible nutrients for each steer per 1000 live weight. The nutritive ratio, actual daily gain and gain per 1000 pounds are also shown. These tables show that although the rations are the cheapest known to us, being wholly composed of bye-products in the process of extracting the oil from cotton-seed, the nutritive effect is remarkably efficient in fattening steers. Much less food than is called for by the German standard for fattening has been needed, while the amounts fed have practically been *ad libitum*.

Preceding this tabular record a series of rations are shown in comparison with the German standard for fattening. These rations show successive steps in reducing our knowledge of the digestibility of these foods nearer and nearer to what is digested.

The prominent objects of this experimental feeding were, as has been stated: (1) To study the effect of different methods of stabling on the rate of gain in fattening steers; (2) The differences which might be found between fattening steers two and three years old under like conditions; and (3) Between steers which might be called grades of beef animals, and such as might be termed natives.

Five of the eight steers used in the experiment were selected by an experienced drover in buying several carloads of stock, and three were taken out of the same general lot for one pair and to match one of the five. Four of these steers were three years old and four two years old. Of the three-year-olds, one pair were natives in appearance and well mated; the other pair were probably grade shorthorns and were badly mated. One was blocky built, while the other was rather taller and thinner. The two year-old steers were matched in the same way as the three-year-olds, and the pairs were well mated.

In case of both lots of two and three-year-old steers, those called grades were much larger than the natives of same age. This difference was so great that the two-year-old-grades were heavier than the three-year-old natives.

Feeding Loose and Tied-up Steers for Beef.—Having the steers thus matched in pairs, natives of same age against grades of same age, it remained to turn one steer of each pair into a comfortable box-stall, while the mate in each pair was tied up to a stanchion to stand on a plank floor, in order to study the difference between the two methods of stabling.

The loose steers had about 131 square feet of room in which to move about, while the four tied-up steers occupied only 31 square feet, or $3\frac{1}{2}$ feet by 9 feet each; or about 12 feet by 9 feet for the four.

The steers were fed for six periods of twenty days each. The proportion of cotton-seed hulls to meal was in the first, second and sixth periods four to one, and six to one for the third, fourth and fifth periods.

The amounts fed per day varied according to the animal and the period of feeding. When the ratio was four to one of hulls and meal, the variation was 14 pounds of hulls and 3.5 pounds meal per head.

to 22 pounds of hulls and 5.5 pounds of meal. When the ratio was seven to one, the variation was 19.5 pounds of hulls and 3.25 pounds of meal to 30 pounds of hulls and 5 pounds of meal. Not all of these daily rations, however, were consumed.

The following is a condensed summary of the result with the eight steers, four being tied up comfortably, and four well bedded in box-stalls and left loose.

	<i>Tied-up Steers.</i>	<i>Loose Steers.</i>
The weights at the beginning of the experiments were	3,186	3,162
At end of first period of twenty days	3,258	3,306
At end of second period of twenty days	3,476	3,473
At end of third period of twenty days	3,663	3,676
At end of fourth period of twenty days	3,763	3,750
At end of fifth period of twenty days	3,857	3,892
At end of sixth period of twenty days	3,951	3,985
Total gain in twenty days	72	144
Total gain in forty days	290	311
Total gain in sixty days	482	514
Total gain in eighty days	576	588
Total gain in one hundred days	671	730
Total gain in one hundred and twenty days	695	823

Some of the steers were sick and lost weight in the first period, to which was probably due the great difference of gain during that period. Following that period the tied-up steers gained fast enough to reduce the difference, until at the end of 80 days they had gained 12 pounds less than the loose steers. During the next 20 days the loose steers made the best gain and led those tied up by 59 pounds at the end of 100 days. At the end of the 120 days the loose steers led by 128 pounds. The four steers tied up had made an average gain of 1.43 pounds per day, while the loose steers had gained 1.72 pounds per day each during the 120 days.

The results of the difference in stabling leads to the conclusion that, other conditions being equal, and the steers kept comfortable in either case, it matters little whether the steers are tied in small space or kept in loose stalls. The gain was slightly in favor of the loose steers, netting only ten cents advantage. The greater cost to enclose the larger area favors tying, while with the former method attendance is lessened.

Feeding Grades and Natives for Beef.—As regards the result between "grade" steers and "native" steers in appearance, four of the former, weighing 3,535 pounds initial weight, consumed 11.6 pounds of cotton-seed hulls and 2.55 pounds of cotton-seed meal for each pound of increase in live weight in 100 days, and gained 680 pounds. During this time the four "native" steers, weighing 2,816 pounds initial weight, consumed 8.62 pounds of the hulls and 1.81 pounds of meal for each pound of increase, and gained 770 pounds. Thus the "natives" in this experiment proved the most profitable feeders.

Feeding Two and Three-year-old Steers for Beef.—The two year-old steers ate but 81.33 per cent. as much hulls and 95.22 per cent. as much meal as did the three-year-olds, while they gained 2.60

per cent. more in relation to their initial weight. The financial statement shows a range from a net loss of \$1.44 to a net gain of \$4.54 per steer; also that the two-year-old steers made a net gain of \$13.02 compared with a net gain of \$7.74 made by the three-year-old steers.

A Good and a Poor Feeder.—Some notes are given on what constitutes a "good" or a "poor feeder." These relate to the square build of the beef form of cattle and lack of it in the poor feeder. It is also noted that while the appetite of the poor-feeding steer was satisfied with less food in relation to his weight, he actually drank much more water than the average of his fellows. This is significant as indicating that some of the food, which might have been stored up as gain, was used in warming and evaporating the extra water.

Water Drank by Animals.—The amount of water drank by animals varies with the live weight to a considerable extent. This is shown to be so great that at times the actual results of feeding might be obscured by it where the gains are small or the periods short. How much water animals require is an interesting point to know. In these experiments, when water and animals were weighed three days in succession, 2.55 for loose steers to 2.74 pounds of water for steers tied up was consumed for each pound of dry matter of cotton-seed hulls and meal. The trials, which were averaged to reach each of these amounts, equal 69 daily records for one steer.

Following this trial, one steer consumed 2.70 pounds of water per pound of dry matter with corn silage and cotton-seed meal. Two other steers, however, required over three pounds of water, including as before that in the silage, but the individuality of these steers made it too great to be reliable.

Silage and Nitrogenous Fodders.—Corn silage with cotton-seed meal was fed for beef with good results in gain of live weight, and the ration was a rational one. Soy (soja) bean silage was also fed with addition of cotton-seed meal and the steers continued to gain in weight after the corn silage period. But this combination was a bad one. Nitrogenous bye-fodder (cotton-seed meal) was shown to increase the digestibility of the large amount of carbohydrates in the corn silage, and thus saves their use in the animal system. The same addition to soy (soja) bean silage is not needed and should not be made.

What is a Maintenance Ration.—A bull was fed on corn silage for a short time, and a total of nine pounds of cotton-seed meal was fed in addition during the first four days. Then corn silage was fed alone, as much as would be eaten (an average of a little more than 44 pounds per day was eaten), for eleven days, and a change was made to soy bean silage, which was fed as much as would be eaten for 46 days, and 44.8 pounds per day were eaten. This resulted in a gain of 1.97 pounds daily for the whole time. This ration, calculated by reliable analyses and digestion coefficients, is shown to be only about three-fourths as large as the German standard for maintenance. The gain shows good enough nutritive effect for fattening at a moderate rate.

Conclusion.—The results reached in this bulletin should go far to encourage the better preparation of beeves for the market. Not alone for the profit in the transaction, but because every dollar's worth of food fed to an animal which can pay it back contributes a quantity of fertilizer to enrich the farm. And further, a better article of beef will be made. This will give satisfaction both to butcher and consumer, and home-made beef will increasingly be demanded.

Feeding stock for beef should be carried on under good shelter protected from wind and storms; and in summer in closed, airy, but darkened stalls where flies and hot sun cannot interfere with the laying on of fat.

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[THE PREVIOUS PAGES PRESENT A CONDENSED SUMMARY OF THE SEVERAL SUBJECTS TREATED IN THIS BULLETIN. THE DETAILED ACCOUNT WILL BE FOUND IN THE FOLLOWING PAGES (9 to 46). PERSONS WHO DO NOT RECEIVE THESE LATTER PAGES CAN BE SUPPLIED BY MAKING APPLICATION TO DR. H. B. BATTLE, DIRECTOR, RALEIGH, N. C.]

FEEDING EXPERIMENTS.

BY F. E. EMERY, AGRICULTURIST.

I. EXPERIMENTS IN FATTENING STOCK FOR BEEF WITH COTTON-SEED HULLS AND MEAL.

A. INTRODUCTORY.

In previous bulletins of this Station the economical use of cheap cattle foods, especially cotton-seed hulls, has been the subject of discussion. They have been shown to be useful and desirable for the purpose of fattening beeves. Digestion experiments have been made to find what portion is utilized by the animal, and to enable us to combine these foods in the best proportions to secure the special end sought in feeding the animals, as well as to study the physiological effect of the food.

It has been, and is being urged upon our people who have land, to try to feed in this way as much stock as they can dispose of in the home market. A benefit will also result to the soil and crops from the plant food thus prepared, quite as much as for the profit from the feeding. In addition, the money paid for this fat beef will again circulate at home instead of being sent away as fast as collected to pay for more beef, while home lands suffer for lack of the rich organic manure which might be thus made at small cost.

In feeding, especially in growing young stock where the very best development of the animal in respect to bone and muscle is sought, it is desirable to give them sufficient room for free and easy exercise, and food to stimulate them to take it, that there may be as full development as possible in every limb and muscle. But when an animal is designed for food, we must make growth as fast as possible consistent with good health, in order to produce that economic production of flesh needed to make the business transaction a profitable one. To this end more or less restriction must be placed on the movements of the fattening animal, as all motion is made at the expense of the food consumed and digested. The less food expended in movements of the animal, and in keeping up the temperature, the more will be left for storing up flesh and fat in the system; since, in the animal economy, the vital functions and movements are first

provided for, and increase of weight must come, if at all, from the surplus after the needs of the system are supplied.

Some confinement, most men believe to be necessary. Just how much will yield the most profit and keep the animals in a healthy condition is not agreed upon. However, nearly all will confine their stock at least for convenience and watering. Some will be content to allow free use of a large yard, or to narrow this space down to a box stall where the animal can turn around easily, stand up, lie down, or lick itself at will. This degree of confinement may still further be reduced to standing hitched in a stall, as in ordinary tying, but still with freedom to stand or lie down, but not to turn around. There may be used the rigid stanchions liked in some stables, which prevent the animals reaching any part of its body with its tongue, though it can lie down and rise at pleasure.

Another item, and quite an important one, is saving the animal excrement during the fattening process in the best and surest way. In stall feeding provision can be made to save the liquid excrement. This, as is well known, can be easily lost, because it is most soluble and easily decomposed and in condition to be readily diluted and carried away by water.

It has been noted in previous experiments that rations of cotton-seed hulls and meal do not agree well with recognized standards, when calculated in the usual way, either in amount of digestible nutrients, or in ratios of protein to carbohydrates. Hence, it seemed desirable to continue feeding hulls and meal in definite proportions, and add to the knowledge gained by digestion experiments already made on these articles. This was done, and the data secured has been elsewhere reported.*

PLAN OF THE EXPERIMENT.

Five steers were carefully selected for the Station by a drover from Southwest Virginia, in buying a drove of beeves for a firm in Raleigh. When brought to Raleigh, three others were selected from the drove, which made up four very even pairs in appearance and in weight, as shown by the scales, as may be seen from the table below.

The selections were made especially to procure two-year-old and three-year-old steers of native types to compare with the beef types, as represented by the shorthorn, or grade shorthorn types of steers. One pair of three-year-olds were apparently grade shorthorns; one of these was of a stout, blocky build, rather lighter than his mate, called "Longhorns," which was tall and thin. The blocky steer called "Broad," was fed loose in box-stall.

The three-year-old natives were very nearly of a size and build, and were considerably smaller than those termed grades.

The two-year-old grades were straight and thrifty. They were a handsome pair, and very nearly matched in form and size, but one

* Bulletin 87d, Experiments 12 and 13.

was a little coarser boned than the other. He was called "Roan," and was fed in box-stall.

The two-year-old natives were fairly well matched.

One of each pair was to be tied upon a platform and the other given a roomy box-stall, to compare the two methods of confining cattle for fattening.

Thus three experiments, besides feeding cotton seed hulls and meal, were to be made upon these steers:

1. Steers confined in stanchions on a platform compared with steers loose in roomy stalls. This is where each individual is given his feed unmolested by any other, and entire freedom in one case to move about. In the other case the feeding is just as free from molestation, but the steers are crowded together, so that a comparatively small space accommodates many more animals. In this experiment, the steers tied up occupied $3\frac{1}{2}$ feet by 9 feet, or only 30 square feet, while the loose steers had 131 square feet each, or more than all four of the other tied-up steers. This is a great consideration where cattle are to be comfortably sheltered from storms and cold winds, as they must be, to secure the most satisfactory returns from feeding in the winter season. In summer, protection from sun and flies is also needed. A darkened stable affords both.

2. The relative fattening of native steers in appearance compared with grade shorthorn steers in appearance. Nothing definite of the breeding can be learned, and they must be classed as they were apparently bred. They were at least good specimens of the types represented, with possibly one exception—Longhorns.

3. Two-year-old compared with three-year-old steers for fattening. If two-year-old steers can be finished off as well as older ones, unless they can be worked to pay for extra keep after two years old, the younger steers can be made most profitable beef.

It was designed to carry the experiment to the block, and secure data as to dressed weights and relative amounts of the best cuts from each steer, but sickness and other causes prevented.

The steers were fed in periods of twenty days each, and in all cases three weights were taken on the mornings of the last two and first day of the next period, for average weights. The weights were always taken before feeding or watering, and the water drunk was weighed on the days previous to each morning on which weights were taken, after the experiment was commenced. This gave data for showing quite closely the influence of the water consumed on the live weight. It may be here stated that the irregularities in the rates of gain shown afterward were largely due to this cause, to the fluctuation in amount of water consumed, or to the time of day at which the greater amounts were taken.

In planning this experiment, it was intended to feed cotton-seed hulls and cotton-seed meal, in proportion of four to one for two twenty-day periods, six to one for two periods, and five to one of two periods of the same length. A variation was made from this

scheme to three periods of six to one, and then one period in which the ration was four to one, in order to make a digestion experiment of hulls and meal with two of these steers fed on these rations and at these ratios.*

THE ANIMALS DESCRIBED.

The eight steers in this experiment were arranged and named as follows when they began to eat cotton-seed hulls and meal:

EACH STEER LOOSE IN A ROOMY BOX-STALL.		EACH STEER TIED UP ON PLATFORM WITH CHAIN.	
<i>Average Weight of Steer. Pounds.</i>		<i>Average Weight of Steer. Pounds.</i>	
907	Broad.....Three-year-old grades	Longhorns	933
839	Roan.....Two-year-old grades	Lineback	828
751	Brindle.....Three-year-old natives	Whiteface	744
641	Red Ears.....Two-year-old natives	Yellow	681
<hr/> 3,162		<hr/> 3,186	

The loose steers were kept in comfortable stalls, each by himself, with slat sides, so that every animal could see others, and the approach of any person in the walks. Those tied up were in the same large room, fastened to upright stanchions by chains made to slide vertically on the same. They were on a plank floor. The loose steers were on the ground with a hard clay surface, but well littered and not cleaned until steers were removed. Both sets of steers were kept comfortably bedded with forest leaves, and in case of those tied up some cotton-seed hulls were used with the leaves, though a less total quantity of bedding was required than was used in the box-stalls.

The steer Broad was of much better beef form than Longhorns, being blocky, while the other was tall, long and comparatively thin. Roan and Lineback were both of good form, though Roan was larger boned and more inclined to grow, while Lineback more readily took on fat. They were well matched.

The three-year-old natives were also well matched. The greatest difference was between the two-year-old natives. The advantage of form and weight were with Yellow, and nearly balanced the weights of the eight, while the difference in form fairly checked that of the three-year old grades.

The steers were put in place and fed several days on green corn, cotton-seed hulls and meal a few days before the experimental feeding actually began, to accustom them to the place and feed.

As usual with stock in a new place, these steers lost weight for several days; so the initial weights for the experiment differ some from those given above on which the steers were matched. These differences may be noted in the tables of weights below.

* See Bulletin 87d, pp. 39-47.

THE HEALTH OF THE ANIMALS.

As the animals began to eat of the hulls freely, the corn was dropped and cotton-seed hulls and meal constituted the only feed allowed, except for awhile during the first period *when some of the steers were sick*.

They had been brought (as stated above) from the southwestern part of Virginia, and were thought to have been attacked with Texas or Splenic Fever in a mild form. Only Broad among the loose steers, and of Lineback and Yellow of those tied up, seemed free from the disease, though only two, Brindle and Longhorns, were affected seriously, or for more than a few days.

The prominent symptoms were loss of appetite, dull look, sluggishness, sunken eyes, swollen joints about the feet, with some fever, scanty urine, scanty dark colored feces which were dry and hard, and more or less covered with bloody mucus. Little or no food was taken by the sickest steers, Brindle and Longhorns, for several days, green corn being preferred to all that was offered them.

Early in Brindle's case, which was the most serious one, a copious injection of soap and warm water was administered, and the steer was given salt and offered fresh water frequently, which induced him to drink more freely than he ate. Nothing more was done for him or any other steer, though all were watched closely, and soon when changes came which indicated a return to health, medicines were not then given.

Longhorns was the only other steer sick enough to need a change of food. He was not removed from his place with the other tied-up steers, except when all were turned into the open part of the shed for a few hours daily, while becoming accustomed to the confinement on the plank floor.

The steers thus disturbed by serious sickness could not be expected to show any effect of the differences of stabling in their changes of weight, hence the record, except the weights for the first period of twenty-days, is omitted, and the two are included in the second period. Brindle's weight, however, was so low at the beginning as to somewhat exaggerate his own and the gain of loose steers when taken together for the second period.

During the whole of the succeeding part of the experiment, the steers were well and ate their rations with apparent relish. No other mishap occurred than a tendency to scour on the part of several, which was ascribed to having licked too freely of the salt kept in the mangers.

THE FOOD USED, AND THE RATION GIVEN.

Cotton-seed hulls were fed in the proportion of four pounds of hulls to one pound of meal during the first, second and sixth periods; six to one in the third, fourth and fifth periods. The experiment was closed

at the end of the sixth period. Two of the steers, Lineback and Yellow, had ripened for the butcher by the end of the fifth period, and only held their own during the sixth.

In this last period, the digestion experiment on cotton-seed hulls and meal was made with those two steers, and the other six, still gaining, were fed at the same rate. Following this sixth period the ratio was widened, and the steers were turned over to the butcher as they seemed fit and were required in his business. Three only were kept on for any considerable time, and these were fed through three short periods on rations of five of hulls to one of meal, with silage and cotton-seed meal fed in the second.

The rations were always calculated for 1,000 pounds weight, approximating as nearly as possible in some respects to the recognized standard with the best data at hand for basis of the calculation. Then the ration was apportioned to each steer in proportion to his weight as affected in some degree by individual appetite. The aim was to give each animal all he could consume. In so doing it appeared that when waste was left it was usually composed of hulls, and consequently there had been consumed a narrower ration than was fed, though in all probability much wider than had been calculated.

Something of this may be seen in the calculated rations given below, which show how the apparently narrow ratio of cotton seed hulls and meal has widened out when we have applied actual digestion, instead of, as in the first cases, calculating from collected data. Rations containing from 17 to 23 pounds of cotton-seed hulls per steer, and one pound of cotton-seed meal for each four pounds of cotton-seed hulls, amounting to 23.53 pounds of hulls and 5.88 pounds of meal for each 1,000 pounds of live weight, when calculated as shown below, yielded the results in the following table.

The ration numbered "4" below is a better average for common use than No. 3, the factors for which have been used to calculate the rations in periods 1, 2 and 6 below, while the same new coefficients were introduced from the digestion of cotton-seed hulls and meal in proportions 6 to 1 for periods 3, 4, and 5.

TABLE I.—AMOUNTS OF CONSTITUENTS FED IN DAILY RATIIONS.

	Total Dry Matter. Lbs.	DIGESTIBLE NUTRIENTS.			Nutritive substance. Lbs.	Nutritive Ratio. 1:—
		Protein. Lbs.	Carbohy- drates. Lbs.	Fat. Lbs.		
1. Daily ration fed during first period, as calculated from data available at time of feeding*.....	27.12	2.535	7.25	1.237	11.022	4.08
2. As calculated, using a new mean composition of hulls and new coefficient of digestibility**.....	25.524	2.045	8.349	1.348	11.742	5.73
3. Recalculated on same compositions, using new coefficients of digestibility for cotton-seed hulls and meal, when fed in ration 4 to 1***.....	25.523	1.74	10.26	1.32	13.33	7.79
4. Recalculated with same coefficients as for "3," and same composition for meal, but with Mr. Kilgore's compilation of five analyses of hulls, which are nearer correct for well cleaned hulls than any of the above quoted. (N. C. Exp. Station Bulletin 90, p. 8.).....	26.25	1.74	10.76	1.128	13.628	7.8
German standard for fattening oxen, first period.....	27.00	2.50	15.00	.50	18.00	6.5
German standard for fattening oxen, second period.....	26.00	3.00	14.80	.70	18.50	5.5
German standard for fattening oxen, third period.....	25.00	2.70	14.80	.60	18.10	6.0

PERCENTAGE COMPOSITION OF FOOD.

	Total dry matter.	Protein.	CARBOHYDRATE.		Fat.	Ash.
			N-Free Extract.	Crude Fiber.		
* Composition of cotton-seed hulls, mean of 10 analyses compiled from various sources by F. E. Emery, 1891.....	90.08	4.23	33.20	47.44	2.24	2.87
* Composition of cotton-seed meal, Dr. E. H. Jenkins, Conn. Exp't Sta. Rep't, 1887, p. 187, averaging 29 analyses.....	91.68	42.39	22.97	5.69	13.37	7.26
* Coefficients for digestibility of cotton-seed hulls, N. C. Exp't Sta., Bulletin 80c, Tech., No. 3.....	35.92	24.61	27.30	40.30	80.61	27.14
* Coefficients of digestibility of cotton-seed meal, Wis. Exp't Sta., Bulletin No. 3, mean of Wolff's and Armsby's determinations.....	77.8	86.8	76.3	0.00	93.8	
** Composition of cotton-seed hulls is a mean of those analyses found in Bulletin 80c, p. 7, and 87d, pp. 34 and 35.....	85.40	4.14	36.35	38.75	3.85	2.31
** Composition of cotton-seed meal, N. C. Exp't Sta., Bulletin 87d, Tech., No. 4.....	92.29	37.867	31.074	5.65	11.075	6.636
** Coefficients of digestibility of cotton-seed hulls, Bulletin 87d, pages 33-35.....	39.82	6.75	36.88	43.14	85.13	19.89
** Coefficients of digestibility of cotton-seed meal, Wis. Exp't Sta. Bulletin cited above.....						
*** Coefficients of digestibility of cotton-seed hulls and meal, fed together in ratio of 4 to 1, N. C. Exp't Sta., Bulletin 87d.....	53.5	54.4	57.9	45.	84.8	46.
*** Coefficients of digestibility of cotton-seed hulls and meal, fed together in ratio of 6 to 1, N. C. Exp't Sta., bulletin 87d.....	46.4	45.8	49.7	40.2	82.1	25.4

TABLE II.—CONSTITUENT PARTS OF FOOD EATEN, WITH AVERAGE WEIGHTS OF ANIMALS.

	Average Weight during Period.	POUNDS EATEN AS LESS POUNDS WASTED.			Dry matter consumed per day and 1000 pounds live weight	POUNDS OF DIGESTIBLE NUTRIENTS CONSUMED PER DAY, AND 1,000 LBS. WEIGHT.					Actual daily gain. Pounds.	Gain per 1000 lbs. weight.	
		Cotton-seed Hulls.	Cotton-seed Meal.			Protein	Carbohy- drate	Fat. (Ether-ex- tract)	Nutri- tive sub- stance.	Ratio 1:—			
FIRST PERIOD.													
Loose Steers.													
Broad, 3-year grade	941	17 46	5 5		21 292	1 620	8 341	1 154	11 112	6 92	3 40	3 612	
Roan, 2-year grade	869	16 21	5 0		21 240	1 605	8 360	1 149	11 114	6 93	3 00	3 45	
Red Ears, 2-year grade	666	11 406	4 25		20 515	1 701	7 901	1 159	10 761	6 35	2 50	3 75	
Averages	825	15 04	4 92		21 016	1 653	8 251	1 161	11 166	6 7			
Tied-up Steers.													
Lineback, 2-year grade	843	16 97	4 7		22 337	1 603	8 892	1 182	11 676	7 39	1 50	1 78	
Whiteface, 3-year native	761	12 13	4 09		18 573	1 466	7 238	1 025	9 729	6 68	1 65	2 17	
Yellow, 2-year native	706	12 825	4 125		20 906	1 613	8 191	1 142	10 946	6 85	2 45	3 47	
Averages	770	13 975	4 305		20 605	1 561	8 140	1 116	10 784	7 00			
SECOND PERIOD.													
Loose Steers.													
Broad, 3-year grade	979	20 97	5 5		23 478	1 639	9 397	1 227	12 263	7 6	2 05	2 094	
Roan, 2-year grade	907	17 17	5 00		21 254	1 562	8 417	1 135	11 114	7 2	0 80	882	
Brindle, 3-year native	751	12 69	3 513		18 747	1 344	7 463	.991	9 798	7 4	3 15	4 194	
Red Ears, 2-year native	715	15 87	4 25		24 440	1 724	9 764	1 284	12 772	7 5	2 35	3 288	
Averages	838	16 675	4 566		21 98	1 567	8 76	1 159	11 487	7 6	2 09	2 615	
Tied-up Steers													
Longhorns, 3-year grade	913	15 75	4 56		21 216	1 468	7 774	1 103	10 345	7 18	2 00	2 19	
Lineback, 2-year grade	883	19 99	5 00		24 559	1 677	9 875	1 272	12 824	7 78	2 55	2 89	
Whiteface, 3-year native	810	17 49	4 50		23 567	1 631	9 623	1 226	12 480	7 78	3 30	4 07	
Yellow, 2-year native	761	16 89	4 25		24 108	1 650	9 689	1 250	12 589	8 00	3 05	4 00	
Averages	842	17 53	4 58		23 36	1 606	9 240	1 213	12 059	7 7	2 72	3 28	

TABLE II.—CONTINUED.

Average Weight during Period.	POUNDS EATEN AS POUNDS FED, LESS POUNDS WASTED.		Dry matter consumed per day and 1000 pounds live weight.	POUNDS OF DIGESTIBLE NUTRIENTS CONSUMED PER DAY, AND 1000 LBS. WEIGHT.					Actual daily gain. Pounds.	Gain per 1000 Lbs. weight.	
	Cotton-seed Hulls.	Cotton-seed Meal.		Protein.	Carbo-hydrate.	Fat. (Ether Extract).	Nutri-tive substance.	Ratio 1:—			
THIRD PERIOD.											
Loose Steers.											
Broad, 3-year grade	1040	21.475	4.512	21.640	1.144	7.715	1.047	9.907	9.03	2.40	2.31
Roan, 2-year grade	944	18.612	3.925	20.675	1.095	7.370	1.002	9.467	9.02	2.95	3.12
Brindle, 3-year native	808	19.290	4.080	25.052	1.329	8.928	1.215	11.472	9.00	2.65	3.28
Red Ears, 2-year native	756	15.818	3.500	22.141	1.200	7.854	1.083	10.137	8.81	2.00	2.64
Averages	887	18.799	4.004	22.377	1.192	7.967	1.087	10.24	8.965	2.50	2.84
Tied-up Steers.											
Longhorns, 3-year grade	956	17.45	3.750	19.208	1.026	6.836	.933	8.795	8.91	2.00	2.09
Lineback, 2-year grade	945	22.16	4.013	23.956	1.180	8.641	1.127	10.948	9.71	2.55	2.70
Whiteface, 3-year native	856	16.075	3.575	19.891	1.081	7.057	.974	9.111	8.78	3.30	3.86
Yellow, 2-year native	812	16.352	3.287	20.935	1.084	7.492	1.005	9.581	9.23	3.05	3.756
Averages	892	18.01	3.656	20.998	1.093	7.506	1.1	9.609	9.14	2.725	3. m.
FOURTH PERIOD.											
Loose Steers.											
Broad, 3-year grade	1070	22.366	4.00	21.302	1.045	7.694	1.001	9.740	9.76	0.60	0.56
Roan, 2-year grade	979	18.33	3.50	19.290	.975	6.933	.917	8.825	9.46	0.50	.51
Brindle, 3-year native	852	18.52	3.41	22.262	1.107	8.023	1.052	10.182	9.62	1.60	1.88
Red Ears, 2-year native	788	15.716	3.25	20.839	1.094	7.440	1.005	9.539	9.10	1.00	1.27
Averages	922	18.73	3.54	20.923	1.055	7.523	.994	9.572	9.485	.925	1.0
Tied-up Steers.											
Longhorns, 3-year grade	986	19.228	3.75	20.164	1.024	7.235	.961	9.926	9.41	0.40	.406
Lineback, 2-year grade	992	21.299	4.00	22.057	1.107	7.955	1.045	10.107	9.53	0.95	.958
Whiteface, 3-year native	888	17.681	3.25	20.383	1.012	7.347	.963	9.822	9.63	1.00	1.126
Yellow, 2-year native	848	18.223	3.50	22.160	1.124	7.961	1.054	10.140	9.43	1.38	1.603
Averages	928	19.108	3.625	21.191	1.067	7.62	1.006	9.70	9.51	.93	1.0

TABLE II.—CONTINUED.

	Average Weight during Period.	POUNDS EATEN AS POUNDS FED, LESS			Dry matter con- sumed per day and 1000 pounds live weight.	POUNDS OF DIGESTIBLE NUTRIENTS CONSUMED PER DAY, AND 1000 LBS. WEIGHT.					Actual daily gain.	Gain per 1000 lbs. weight.	
		POUNDS WASTED.		Protein.		Carbo- hydrate	Fat. (Ether Extr'ct)	Nutri- tive sub- stance.	Ratio 1:—				
		Cotton- seed Hulls.	Cotton- seed Meal.										
FIFTH PERIOD.													
Loose Steers.													
Broad, 3-year grade	1093	22.675	4.25		21.305	1.068	1.668	1.009	9.745	9.54	1.70	1.556	
Roan, 2-year grade	1006	18.416	3.50		18.843	.950	6.775	.895	8.621	9.48	2.45	2.137	
Brindle, 3-year native	885	19.097	3.50		22.078	1.096	7.960	1.012	10.098	9.64	1.70	1.920	
Red Ears, 2-year native	812	16.147	3.25		20.677	1.071	7.399	.993	9.463	9.22	1.55	1.909	
Averages	949	19.054	3.625		20.726	1.046	7.451	.985	9.482	9.47	1.775	1.8	
Tied-up Steers.													
Longhorns, 3-year grade	1008	20.519	3.75		20.807	1.031	7.501	.981	9.628	9.66	1.55	1.537	
Lineback, 2-year grade	1011	20.894	3.75		21.072	1.036	7.610	.990	9.636	9.74	.95	.940	
Whiteface, 3-year native	923	18.924	3.25		20.759	.999	7.522	.967	9.490	9.95	1.50	1.625	
Yellow, 2-year native	869	18.538	3.25		21.670	1.053	7.839	1.015	9.907	9.86	.725	.834	
Averages	953	19.719	3.50		21.077	1.03	7.618	.988	9.	9.80	1.18	1.2	
SIXTH PERIOD.													
Loose Steers.													
Broad, 3-year grade	1124	25.556	5.713		24.108	1.560	9.794	1.220	12.574	8.23	1.35	1.201	
Roan, 2-year grade	1041	15.847	4.325		16.834	1.199	6.72	.887	8.796	7.45	1.40	1.340	
Brindle, 3-year native	909	15.872	4.30		19.277	1.369	7.691	1.014	10.074	7.47	0.70	0.770	
Red Ears, 2-year native	841	13.678	4.20		18.498	1.460	7.284	1.000	9.744	6.70	1.20	1.427	
Averages	979	17.738	4.63		19.679	1.397	7.872	1.03	10.	7.46	1.16	1.18	
Tied-up Steers.													
Longhorns, 3-year grade	1027	19.616	5.125		20.717	1.459	8.360	1.093	10.911	7.604	.40	.39	
Lineback, 2-year grade	1020	19.077	4.944		20.440	1.421	7.624	1.066	10.111	7.24	0.90	0.00	
Whiteface, 3-year native	952	18.381	4.988		20.274	1.515	8.507	1.113	11.134	7.45	1.35	1.42	
Yellow, 2-year native	870	16.320	4.481		20.773	1.484	8.277	1.095	10.902	7.59	.55	.63	
Averages	967	18.319	4.88		20.551	1.47	8.192	1.092	10.765	7.48	.575	.6 nly	

THE AMOUNT OF CONSTITUENTS EATEN AND THE WEIGHTS RECORDED.

The preceding table shows for each period the average weight of each steer, the food actually eaten, the total dry matter contained, the amount of each constituent digestible per 1,000 pounds live weight, the total pounds of digestible nutrients, the ratio, the actual daily gain, as well as the gain per day and 1,000 pounds live weight.

The calculated rations, 1, 2 and 3, given in the first table, show something of the uncertainty of dependence on averages, and the misleading character of calculations thus based. Our first observations showed that when feeding quite narrow rations there were good gains made, yet the figures suggested too heavy feeding with cotton-seed meal. There is so little protein in the hulls that the large amount in the meal only serves to "balance" the ration when meal is fed liberally, that is, in proportion of three or four pounds of hulls. This will be regarded as heavy feeding when steers are fed all they can consume, but it has been found that under this kind of feeding the looked for result is obtained, while we have shown (Bulletin 87d) that the greater the proportion of meal fed in the ration, so far as the investigation has gone, the greater will be the percentage of digestibility. Hence a given amount of food will give a greater effect when fed in narrower ratios of fresh substance than has hitherto been regarded advisable. There will be a double saving, as has been previous'y and frequently pointed out by other writers in advocating rational feeding of stock, in increased gain from the stock by the saving in the food which otherwise would have been lost. This narrowing of the actual ratio in rations will receive further attention in another digestion bulletin. Here we have essayed to show what the fattening effect has been of rations composed of cotton-seed hulls and meal in the given proportions on thrifty steers half fat to start with under favorable conditions as to climate and comfort of the individuals in both groups

B. COMPARISON OF RESULTS.

1. STEERS LOOSE IN ROOMY STALLS AGAINST STEERS TIED-UP IN NARROW STANCHIONS.

THE THREE PERIODS.

These rations were intended to have been fed in two periods each, the last two to have been five of hulls to one of meal, and the variations were made as above stated to get digestibility of hulls and meal when it could be done, and keep the steers all on the same basis as near as possible in what was offered them. The individuality affects the ration consumed to a considerable extent, as

does many other lesser circumstances, but the tendency is to eliminate these when the weights for a number of animals are averaged. In the present case, during the first period, there are but two pairs fairly comparable, since one each from the other two pairs was sick. These two pairs are the two-year-olds. On practically the same amount of dry matter, the tied-up steers ate most hulls by over two pounds daily, and less meal by more than one-fifth pound daily. This gave them less protein but more carbohydrate and a wider ratio with apparently less daily gains per 1,000 pounds by 1.55 pounds. This apparent advantage may be less than appears. (See discussion of time and amount of water consumed.)

Passing on to the second period and taking up all four pairs the sick three-year-old grade steer, Longhorns, is found to have recovered slowly and to have been comparatively one of the poorest feeders, while the other sick steer Brindle, a loose steer, was most reduced, but built up rapidly and well, proving one of the best feeders. This favored the loose steers, but during this period, on almost equal average weight, the tied-up steers took the lead in the amount of food consumed by eating nearly a pound more hulls and a trifle more meal than the others. This gave them more nutritive substance with practically the same ratio, 1 of protein to 7.7 of carbohydrates, and with the gain rather in their favor, but not nearly as much as was the difference between the two pairs at the first comparison.

The third period was the first in which the ratio of hulls fed was 6 to 1 of meal fed. The ratio of digestible protein to digestible carbohydrate was 1 to 8.97 for the loose steers, and 1 to 9.17 for tied steers. This change widened the ratio of the ration consumed from 1.76 to 1.77, respectively, to the above. The tied steers ate less of hulls and meal in the first period on this ration than did the loose steers, and gained less in weight; but in the next period (the fourth) this lot led a little in food consumed and in gain of weight, though when calculated on 1000 pounds weight, they were even, with 1 pound gain per day.

During the fifth period (3d on this ration) the tied-up steers ate most hulls and less meal than did the loose steers. This difference was so slight that it gave the tied steers more dry matter and nutritive substance, while loose steers had a little more protein and made more gain in weight than the tied steers by 6 pounds per day and 1000 pounds weight.

During the third period a digestion experiment was made of the ration of cotton-seed hulls and meal at the rate of 6 to 1, using the steers Lineback and Yellow.* It will be noted in the table showing gains, that the steers did not seem to have minded the attendants at all, but made as much gain in weight as at any time.

This ration was consumed at the rate of about 1 of meal to 4.9 or 5.00 of hulls. Its being fed the third period of twenty days leaves a more favorable impression, and gave more return than if it had been fed for the 40 days.

*Bulletin 87d, pp. 39—43.

The ration for period six was made to accommodate another digestion experiment with cotton-seed hulls and meal 4 to 1.*

During this period steer Lineback just held his weight and Yellow fell back 11 pounds, or .63 pounds per day. This was ascribed to having reached the point of their highest development for beef. Before the digestion experiment was begun, these steers were regarded as "ripe" and likely to cease gaining, but having proved tractable in the previous trial, and the other steers seemingly all in good thrifty condition, it was decided to continue the feeding to the end of the period. These two steers were doubtless at the end of profitable feeding by the end of the fifth period. Therefore these two and their mates are dropped, and only the three-year-olds considered during the sixth period. This gives 100 days feed for all of both lots by commencing at the beginning of the second period and closing the experiment with the sixth. All the steers except Lineback and Yellow gained in weight, but at a slower rate than before. Red Ears gained the most when calculated to 1,000 pounds, while Longhorns made the least gain.

FOOD CONSUMED IN EACH PERIOD.

The food consumed per day by each set of steers for each period has been brought together in the following table for convenience in making comparisons. The average live weight is a mean between the weight at the beginning and end of each period. The food columns show the average pounds of cotton-seed hulls and meal actually eaten, while the total dry matter eaten per 1,000 pounds of live weight is shown at column four. The rest of the table is calculated to an average of 1,000 pounds live weight, except the column showing average daily gain:

*See Bulletin 87d, pp. 42--47.

TABLE III.—FOOD CONSUMED IN EACH PERIOD, WITH GAINS PER DAY.

	Average Weight (Pounds).	POUNDS EATEN AS POUNDS FED, LESS POUNDS WASTE.		Total Dry Matter Consumed Per Day, and 1000 Lbs. Weight.	DIGESTIBLE NUTRIENTS CONSUMED PER DAY, AND 1000 LBS. LIVE WEIGHT.				Nutritive Sub- stance (Pounds).	Ratio 1 Protein to Carbohydrate:—	Actual Average Daily Gain (Lbs).	Gain Per 1000 Lbs. Weight Per Day.	
		Cotton- seed hulls.	Cotton- seed meal.		Protein.	Carbo- hydrates.	Fat (Ether Extract).						
LOOSE STEERS:													
1st Period—2 steers:													
Roan. Red Ears.....	768	13.808	4.625	20.878	1.653	8.13	1.154	10.938	6.64	2.75	3.75		
2d Period—4 steers.....	838	16.675	4.566	21.98	1.567	8.76	1.159	11.487	7.6	2.09	2.615		
3d Period—4 steers.....	887	18.799	4.004	22.377	1.192	7.967	1.087	10.24	8.965	2.50	2.84		
4th Period—4 steers.....	922	18.73	3.54	20.923	1.055	7.523	.994	9.585	9.49	.925	1.00		
5th Period—4 steers.....	949	19.084	3.625	20.726	1.046	7.453	.985	9.482	9.47	1.775	1.80		
6th Period—2 steers.....	1017	20.714	5.007	21.693	1.465	8.743	1.117	11.667	7.85	1.025	.986		
TIED-UP STEERS:													
1st Period—2 steers:													
Lineback, Yellow.....	775	14.898	4.4125	20.864	1.608	8.541	1.162	11.311	7.12	1.975	2.625		
2d Period—4 steers.....	842	17.53	4.58	23.36	1.606	9.339	1.213	12.062	7.7	2.72	3.28		
3d Period—4 steers.....	892	18.01	3.656	20.998	1.093	7.507	1.01	9.609	9.14	2.725	3.00		
4th Period—4 steers.....	928	19.108	3.625	21.191	1.067	7.620	1.006	9.702	9.51	.93	1.00		
5th Period—4 steers.....	953	19.719	3.50	21.077	1.03	7.618	0.988	9.668	9.80	1.18	1.20		
6th Period—2 steers.....	990	18.999	5.057	20.496	1.487	8.434	1.103	11.023	7.527	0.875	0.905		
GERMAN FEEDING STANDARD:													
For Fattening Cattle:													
1st Period.....				TOTAL ORGANIC* MATTER.									
2d Period.....				27.00	2.50	15.00	0.50	18.00	1:6.5				
3d Period.....				26.00	3.00	14.80	0.70	18.50	1:5.5				
For Growing Cattle:				25.00	2.70	14.80	0.60	18.10	1:6.0				
18-24 months old.....	850			24.00	1.60	12.00	0.30	13.9	1:8.00				
Actual ration per head.....													
				20.40	1.40	10.30	0.26	11.96	1:8.00				

*Same as "Total Dry Matter" above, less percentage of ash.

By inspecting the above table, it will be seen that at no one of the periods did the ration fed approach nearer the German standard for fattening than in the first, where the protein was 62 per cent. of that standard, the combined carbohydrates and fat 67.78 per cent. of the standard amount of carbohydrate plus $2\frac{1}{2}$ times the fat, although the fat in our ration, 1.154 pounds per 1,000 pounds live weight, was .654 pounds more or 215.4 per cent. of the standard. The digestible nutritive substance was but 60.76 per cent. of that in the standard.

During the feeding of the wide ratio 6 to 1 of hulls to meal, the ration was at all times poorer than the standard for growing young cattle, yet it was sufficient to produce a good gain in these steers. During this period the gain was probably the growth of the smaller steers, an increase in size quite as much as of fat, but they were well prepared for the block when after the sixth 20-day period they were sold for beef.

On the last period, with the three-year old steers, the ration corresponded poorly with the standard for growing cattle. The protein was but 93 per cent. of standard, while carbohydrates were 70.3 and ether extract (367.7 per cent., and both combined were 87.76 per cent. only of the standard). Digestible nutrients were 79.3 per cent. only of the standard. Yet this ration, showing these percentages of the standard for growing young animals of 18 to 24 months old, fattened these steers so well that they were called prime beef at the Raleigh market.

TABLE IV.—SHOWING TOTAL GAINS IN POUNDS OF ALL STEERS FOR THE WHOLE TIME, BY PERIODS.

	Broad.	Longhorns.	Brindle.	Whiteface.	Roan.	Lineback.	Red Ears.	Yellow.
First Period of 20 days.....	68.	40.	34.	33.	60.	30.	50.	49.
Second Period of 20 days...	41.	40.	63.	66.	16.	51.	47.	61.
Third Period of 20 days.....	48.	51.	56.	25.	59.	73.	40.	43.
Fourth Period of 20 days...	12.	8.	33.	40.	10.	19.	20.	27.5
Fifth Period of 20 days.....	34.	31.	34.	30.	43.	19.	31.	14.5
Sixth Period of 20 days.....	27.	8.	14.	27.	28.	00.	24.	—11.
Totals.....	230.	98.	165.	221.	216.	192.	272.	184.

TOTAL GAIN FOR EACH STEER.

The total gains show the following result for this experiment:

LOOSE STEERS			TIED-UP STEERS		
	Weight at Close of Experiment.	Gain.		Weight at Close of Experiment.	Gain.
Broad.....	1137 Lbs.	230 Lbs.	Longhorns.....	1031 Lbs.	98 Lbs.
Brindle.....	916 "	165 "	Whiteface.....	965 "	221 "
Roan.....	1055 "	216 "	Lineback.....	1120 "	192 "
Red Ears.....	853 "	212 "	Yellow.....	815 "	184 "

That is, four steers of 3,133 pounds initial weight gained 823 pounds in 120 days when kept in large box-stalls and fed liberally on cotton-seed hulls and meal. During the same time, four other steers of nearly like size and characteristics, fed just as liberally by the same hands and in the same room, but tied up on a platform, gained 695 pounds on 3,186 pounds initial weight. This is a gain of slightly more than one-fourth pound per day and per steer in favor of the loose stalls.

But two of the steers were sick for the first period and two others prepared for market one period in advance of the termination of the experiment. Considering all the steers, except the pairs thus unbalanced in the first and sixth periods, gives the following comparison for two pairs each in the first and last periods, and all the steers in the four intermediate periods: Gained by loose steers, 737 pounds; by steers tied up, 713 pounds, 24 pounds weight in favor of the loose stalls, on two steers 40 days, and on four steers 80 days, or equal to one steer 400 days, which gain is insignificant.

Dropping the two pairs of three-year-old steers unbalanced during the first period and the two pairs of two-year-olds in the sixth period, leaves just 100 days for each lot. Below is shown the amount of cotton-seed hulls and meal required for each lot of loose and tied-up steers to make the gains shown above for this period:

TABLE V.—COTTON-SEED HULLS AND MEAL EATEN IN 100 DAYS.

TIED-UP STEERS.			LOOSE STEERS.		
	Cotton-seed Hulls. Lbs.	Cotton-seed Meal. Lbs.		Cotton-seed Hulls. Lbs.	Cotton-seed Meal. Lbs.
Longhorns, 3-yr. grade	1851.26	408.	Broad, 3-yr. grade	2260.82	479.50
Whiteface, 3-yr. native	1770.95	391.25	Brindle, 3-yr. native	1709.29	376.25
Linback, 2-yr. grade	2003.43	429.25	Roan, 2-yr. grade	1774.88	418.56
Yellow, 2-yr. native	1656.62	346.81	Red Ears, 2-yr. native	1499.13	275.75
Total	7282.26	1596.71	Total	7244.12	1644.25
Required for 100 Lbs. gain in weight	1021.35	223.94		1016.00	230.71
For 1 pound gain	10.21	2.94		10.16	2.31

Taking the gains in weight of all the steers for the 2d, 3d, 4th, and 5th periods they amounted to, for loose steers, 586 pounds; and for the steers tied up, 599 pounds, a small balance in favor of tying.

CONCLUSION.

The significance of this trial is in the fact that if stock are made comfortable and kept quiet and contented and well fed, with kind treatment, it does not matter in feeding for fattening purposes whether

they are tied or turned loose in a limited range. Each feeder should then consider his own convenience, the difference in cost of the greater or less housing area required, and the appliances for tying. He should study to keep stock free from exposure to cold winds and from rain, for his own financial gain, even if he cares nothing for the animals from higher motives, which should certainly lead everyone having control of dumb domestic animals to seek their well being without consulting the gain from so doing.

2. NATIVE STEERS IN APPEARANCE AGAINST GRADES IN APPEARANCE.

The same steers just under discussion were regarded as falling under the above heading by appearance. They were all good specimens; but if any were better than the class they were chosen to represent, it was the natives, which were far better than the steers driven on the road from counties supplying the Raleigh markets.

The comparison between steers loose and tied up was between mates of like pairs, as far as possible of the same ages and appearance, and nearly even weights. This comparison is between very unlike steers in appearance and weight, but of the same ages, as near as may have been, and with like stabling and feed.

GAINS RECORDED.

Considering comparisons of gains in weight here, the same as above, we find the following: One each of the pairs of older steers was sick the first period, hence for that period there were but four steers to be fairly compared. Dropping this four in the sixth period, because one of each was prepared for market and would suffer in the comparison, while the earlier maturity was really in their favor, we have in this comparison eight steers for 100 days feeding. Four grade steers, weighing 3,535 pounds at the beginning of the periods considered, gained 680 pounds in 100 days. Four native steers, weighing 2,816 pounds, gained 770 pounds in the same time.

FOOD EATEN.

The statement is not complete without being coupled with the amount of food consumed by each set of steers, which is given below, in condensed form, from Table VI. below.

The following table shows that while the average weight was smaller, the "native" steers ate a little more than did the "grade" steers. Trifling though it may seem, this difference, combined with the difference in their favor of 180 pounds less weight to support, and an average for the whole time of 161 pounds less, was sufficient when combined on the same side to fix the advantage with the smaller native steers.

TABLE VI.—AVERAGE LIVE WEIGHTS AND FOOD EATEN PER 1,000 POUNDS LIVE WEIGHT.

	Ages of Steers.	Average Live Weight (Lbs.).	Total Dry Matter consumed per 1000 Lbs. w't.	Protein(Pounds).	Carbohydrates (Pounds).	Fat (Ether Extract) Lbs.	Nutritive Substance (Lbs.).
<i>Grade Steers.</i>							
Lineback	2 years	935	22.796	1.32	8.60	1.12	11.04
Roan	2 years	941	20.260	1.24	7.57	1.02	9.83
Longhorns	3 years	979	20.422	1.20	7.53	1.01	9.78
Broad	3 years	1061	22.367	1.29	8.45	1.10	10.85
Average per day and per steer for 100 days		979	21.46	1.26	8.04	1.06	10.37
<i>Native Steers.</i>							
Yellow	2 years	799	21.956	1.31	8.23	1.09	10.63
Red Ears	2 years	747	21.823	1.36	8.07	1.11	10.54
Whiteface	3 years	886	20.975	1.25	8.01	1.05	10.31
Brindle	3 years	841	21.483	1.25	8.02	1.06	10.32
Average per day and per steer for 100 days		818	21.56	1.29	8.08	1.08	10.45

The gain in per cent. of the live weight at the time of entering on the 100 days feeding was, for grade steers, 19.23 per cent.; for native steers, 27.34 per cent.

The food actually eaten by each set of steers, and amounts required for 100 pounds of gain, were as given in the following table:

TABLE VII.—FOOD EATEN BY STEERS IN 100 DAYS, ARRANGED BY BREEDING.

NATIVE STEERS.			GRADE STEERS.		
	Cotton-seed Hulls Eaten (Pounds).	Cotton-seed Meal Eaten (Pounds).		Cotton-seed Hulls Eaten (Pounds).	Cotton-seed Meal Eaten (Pounds).
Brindle	1709.29	376.25	Broad	2260.82	479.50
Whiteface	1770.95	391.25	Longhorns	1851.26	408.00
Red Ears	1499.13	275.75	Roan	1774.88	418.50
Yellow	1656.62	346.81	Lineback	2003.43	429.25
	6634.99	1390.06		7890.39	1735.25
Required for 100 pounds gain	816.7	180.53	Required for 100 pounds gain	1160.35	255.2
Required for one pound gain	8.62	1.81	Required for one pound gain	11.6	2.55

These native steers proved to be excellent feeders, and thrive so well we can only wish the experiment could have been continued to the block, and relative amounts of the choicest cuts could have been shown, together with the dressed weights.

3. TWO-YEAR-OLD STEERS AGAINST THREE-YEAR-OLD STEERS.

Combining the steers into these two groups, and using the same periods and data given above, we come to the conclusions recorded below.

If, instead of dropping some of the steers in the first and sixth periods, they had been retained and all reported for the whole 120 days, the gain would have been greater in favor of the two-year-old steers by 18.4 per cent. more than the difference between the two groups for 100 days.

FOOD EATEN AND GAINS MADE.

Referring to the general averages of weights of animals and food consumed during the whole 100 days feeding, as per Table VI, the following may be noted:

The grades Broad and Lineback, three-year-old and two year-old, were the heartiest feeders. One of these (Broad) was loose and one (Lineback) tied. The other two grades were the lightest feeders. The two smallest steers were the heartiest, next to Broad and Lineback. The other two three-year-old natives were nearly average feeders.

TABLE VIII.—FOOD EATEN BY STEERS IN 100 DAYS, ARRANGED BY AGE.

THREE-YEAR-OLDS.				TWO-YEAR-OLDS.			
		Cotton- seed Hulls Eaten.	Cotton- seed Meal Eaten.			Cotton- seed Hulls Eaten.	Cotton- seed Meal Eaten.
Longhorns } Whiteface }	Tied ...	3622.21	799.25	Lineback } Yellow }	Tied	3660.05	797.46
Broad } Brindle }	Loose	3970.11	855.75	Roan } Red Ears }	Loose	3274.01	788.50
		7592.32	1655.00			6934.06	1575.96
Required for 100 Lbs. gain		1105.14	240.90	Required for 100 Lbs. gain		908.79	206.54
Required for 1 pound...		11.05	2.41	Required for 1 pound.		9.09	2.07

By the exhibits in Table VIII, it is seen that the three-year-old steers consumed 658.26 pounds more of hulls and 79.04 pounds more of meal than did the two-year-old steers. The total eaten supported the initial live weight, 3,362 pounds, of the three-year-old

group, and added 687 pounds of weight in 100 days. The initial weight of two-year-old steers was 2,989 pounds, and they gained 763 pounds on this smaller total weight in 100 days, while eating the less total amount of food. Thus gaining more than the three-year-olds in relation to initial live weight, by the following:

Three-year-old steers	{	2.26	times initial weight of cotton-seed hulls.
ate in 100 days,	{	.492	times initial weight of cotton-seed meal.
Two-year-old steers	{	2.23	times initial weight of cotton-seed hulls.
ate in 100 days,	{	.527	times initial weight of cotton-seed meal.

The gain of the three-year-old steers amounted to 20.43 per cent. of initial weight, and that of the two-year-old steers to 23.03 per cent.

The food consumed by the two-year-old steers was slightly greater in proportion to initial weight than that consumed by the three-year-old steers, but the total amount was 81.33 pounds of hulls and 95.22 pounds of meal for every 100 of each eaten by the three-year-olds, and on this smaller amount they gained 2.60 per cent. more in relation to initial weight.

C. FINANCIAL STATEMENTS.

The steers purchased for this experiment were brought to Raleigh for beef, hence had presumably been fed up to the point where stockfeeder, drover and butcher considered them fit for beef. The price of the steers was regarded high at the time of the purchase, and for five of them 3 cents per pound was paid, and for three $3\frac{1}{4}$ cents per pound. From the time of purchase until the initial weights were taken, there was a shrinkage of 50 pounds on the so-called grade steers, and 40 pounds on the native steers. The steers were fed after the close of the experiment before taken by the butcher. Two of the tied-up steers, Lineback and Yellow, together with Broad, a loose steer, were at once taken; on the others the following gains were made before taken: Roan 10 pounds, Red Ears 12 pounds, Longhorns 24 pounds, Whiteface 44 pounds, and Brindle 48 pounds.

BALANCE SHEET FOR 100 DAYS.

The above gains may be regarded as about balancing the losses at first and to pay for food, and our balance taken from the initial and closing weights can be considered as about the actual transaction, though for the reason stated more was paid and more received for the steers than appears. This balance is for the 100 days feeding as has been discussed, and is made at the buying and selling rate per pound.

LOOSE STEERS.		DR.	CR.
<i>Broad</i> —Three-year-old grade:			
907	pounds live weight, bought at $3\frac{1}{4}$ c.....	\$ 29.48	
2260.8	pounds cotton-seed hulls, at \$2.50 per ton.....	2.82	
479.5	pounds cotton-seed meal, \$24.....	5.75	
1137	pounds live weight sold, at $3\frac{1}{4}$ c.....		\$ 39.80
	Net gain	1.75	
		<u>\$ 39.80</u>	<u>\$ 39.80</u>

Roan—Two-year-old grade:

	DR.	CR.
859 pounds live weight, bought at $3\frac{1}{2}$ c	\$ 28.92	
1774.88 pounds cotton-seed hulls, at \$2.50	2.22	
418.5 pounds cotton seed meal, at \$24	5.02	
1055 pounds live weight, sold at $3\frac{1}{2}$		\$ 36.92
Net gain76	
	<u>\$ 36.92</u>	<u>\$ 36.92</u>

Brindle—Three-year-old native:

751 pounds live weight, bought at 3c	\$ 22.52	
1709.3 pounds cotton-seed hulls	2.14	
376.25 pounds cotton-seed meal	5.51	
916 pounds live weight, sold at $3\frac{1}{2}$		\$ 32.06
Net gain	2.88	
	<u>\$ 32.06</u>	<u>\$ 32.06</u>

Red Ears—Two-year-old native:

641 pounds live weight, bought at 3c	\$19.23	
1499.13 pounds cotton-seed hulls	1.874	
275.75 pounds cotton-seed meal	3.309	
853 pounds live weight, sold at $3\frac{1}{2}$ c		\$29.855
Net gain	5.442	
	<u>\$29.855</u>	<u>\$29.855</u>

TIED-UP STEERS.

Longhorns—Three-year-old grade:

933 pounds live weight, bought at $3\frac{1}{2}$ c	\$ 30.32	
1851 pounds cotton-seed hulls, at \$2.50 per ton	2.31	
408 pounds cotton-seed meal, at \$24 per ton	4.90	
1031 pounds live weight, sold at $3\frac{1}{2}$ c		\$ 36.09
Net loss		—1.44
	<u>\$ 37.53</u>	<u>\$ 37.53</u>

Lineback—Two-year-old grade:

828 pounds live weight, bought at 3c	\$ 24.84	
2003.43 pounds cotton-seed hulls	5.15	
429.25 pounds cotton-seed meal	2.50	
1020 pounds live weight, sold at $3\frac{1}{2}$ c		\$ 35.70
Net gain	3.21	
	<u>\$ 35.70</u>	<u>\$ 35.70</u>

Whiteface—Three-year-old native:

744 pounds live weight, bought at 3c	\$22.32	
1770.95 pounds cotton-seed hulls	2.214	
391.25 pounds cotton-seed meal	4.695	
965 pounds live weight, sold at $3\frac{1}{2}$		\$33.775
Net gain	4.546	
	<u>\$33.775</u>	<u>\$33.775</u>

Yellow—Two-year-old native:

681 pounds live weight, bought at 3c	\$20.43	
1656.62 pounds cotton-seed hulls	2.071	
346.81 pounds cotton-seed meal	4.162	
865 pounds live weight, sold at $3\frac{1}{2}$		\$30.275
Net gain	3.612	
	<u>\$30.275</u>	<u>\$30.275</u>

This shows a fair gain on every steer except Roan and Longhorns. The net gain on loose steers was \$9.83; on tied up steers, \$9.93, which is only a difference of ten cents in 100 days feeding.

Considering this test as grades *vs.* native steers, there is only \$4.28 gained to the credit of the grade Shorthorn steers, while from the natives there was a net gain of \$16.48.

As between three-year-olds and two-year-olds, the former gained \$7.74, and the two-year-old steers \$13.02—nearly twice as much as from the three-year-olds.

The heavier three year-olds were doubtless better prepared than were the two-year-olds, but, nevertheless, what a striking commentary on the beef brought to this market! These were all above average local stock as it comes into market for two to two and a half cents per pound.

RESUME SHOWING TOTAL FOOD CONSUMED, AND COMPLETE TRANS-
ACTION FOR EACH STEER.

This statement includes all food consumed by each steer after the first few days, when they were becoming accustomed to a diet of cotton-seed hulls and meal, to the evening before they were taken away for beef. One exception was in case of the steer, Brindle, for a period of twelve days, while sick, ate no food for several days, and so little for the remainder that no account was made of it. A considerable variety of food was offered, but to no purpose, as the steer was too sick to eat.

Broad—Three-year-old grade—loose. Well all the time, and fed 121 days:

	Dr.	Cr.
Purchased weight, 930 pounds, at 3½c	\$ 30.22	
Cotton-seed hulls, 2638 8 pounds, at \$2 50 per ton	3.30	
Cotton-seed meal, 576 25 pounds, at \$24 per ton	6.91	
Selling weight, 1137 pounds, at 3½c		\$ 39.79
Balance net loss64
	<hr/> \$ 40.43	<hr/> \$ 40.43

Longhorns—Three-year-old grade—tied. Fed 126 days; sick and off feed about two weeks within first 20 days:

Purchased weight, 966 pounds, at 3½c	\$ 31.40	
Cotton-seed hulls, 2278.39 pounds, at \$2.50 per ton	2.85	
Cotton-seed meal, 614.75 pounds, at \$24 per ton	7.38	
Green corn, 142.3 pounds, at \$3.50 per ton	0.18	
Corn silage, 489.6 pounds, at \$3.00 per ton73	
Selling weight, 1055 pounds, at 3½c		\$ 36.94
Balance net loss		5.61
	<hr/> \$ 42.54	<hr/> \$ 42.54

Roan—Two-year-old grade—loose. Fed 127 days; well all the time:

Purchased weight, 844 pounds, at 3½c	\$ 27.43	
Cotton-seed hulls, 2224.2 pounds, at \$2.50 per ton	2.78	
Cotton-seed meal, 541 pounds, at \$24 per ton	6.49	
Selling weight, 1065 pounds, at 3½c		\$ 37.27
Balance net gain57	
	<hr/> \$ 37.27	<hr/> \$ 37.27

<i>Lineback</i> —Two-year-old grade—tied. Fed 120 days; well all the time; ripe for the block at least 20 days before feeding ceased:			Dr.	Cr.
Purchased weight, 817 pounds, at 3c	\$ 24.51			
Cotton-seed hulls, 2384.97 pounds, at \$2.50 per ton	2.98			
Cotton-seed meal, 528.125 pounds, at \$24 per ton	6.34			
Selling weight, 1020 pounds, at 3½c		\$ 35.70		
Balance net gain	1.87			
	<u>\$ 35.70</u>	<u>\$ 35.70</u>		

<i>Yellow</i> —Two-year-old native—tied. Fed 120 days; well all the time; ripe for the block with Lineback:				
Purchased weight, 683 pounds, at 3c	\$ 20.49			
Cotton-seed hulls, 1933 pounds, at \$2.50 per ton	2.45			
Cotton-seed meal, 436.44 pounds, at \$24 per ton	5.24			
Selling weight, 865 pounds, at 3½c		\$ 30.28		
Balance net gain	2.10			
	<u>\$ 30.28</u>	<u>\$ 30.28</u>		

<i>Red Ears</i> —Two-year-old native—loose. Fed 126 days; well all the time:				
Purchased weight, 645 pounds, at 3c	\$ 19.35			
Cotton-seed hulls, 1859 pounds, at \$2.50 per ton	2.32			
Cotton-seed meal, 386.25 pounds, at \$24 per ton	4.64			
Selling weight, 855 pounds, at 3½c		\$ 29.93		
Balance net gain	3.62			
	<u>\$ 29.93</u>	<u>\$ 29.93</u>		

<i>Whiteface</i> —Three-year-old native—tied. Fed 155 days; well all the time:				
Purchased weight, 756 pounds, at 3c	\$ 22.68			
Cotton-seed hulls, 2215 pounds, at \$2.50 per ton	2.77			
Cotton-seed meal, 643 pounds, at \$24 per ton	7.72			
Corn silage, 328 pounds, at \$3 per ton49			
Selling weight, 1009 pounds, at 3½c		\$ 35.81		
Balance net gain	1.65			
	<u>\$ 35.81</u>	<u>\$ 35.81</u>		

<i>Brindle</i> —Three-year-old native—loose. Fed 154 days; sick about two weeks during first 20 days:				
Purchased weight, 775 pounds, at 3c	\$ 23.25			
Cotton-seed hulls, 2183.73 pounds, at \$2.50 per ton	2.73			
Cotton-seed meal, 563.75 pounds, at \$24 per ton	6.77			
Green corn, —? pounds, at \$2.50 per ton66			
Corn silage, 443 4 pounds, at \$3.00 per ton		\$ 33.74		
Selling weight, 964 pounds, at 3½c				
Balance net gain33			
	<u>\$ 33.74</u>	<u>\$ 33.74</u>		

This shows that on the whole time of feeding the eight steers made a total gain of \$3 89.

A loss was made on two steers—the three-year-old grades. The loss was small on Broad, but very heavy on the poor feeder Longhorns. Had Broad been purchased at the same price as the smaller steers there would have been a gain of \$1.68 cents on him, and at the same cost the loss on Longhorns would have been reduced to

\$3.19. Also if Roan had cost but 3 cents per pound the gain would have been raised from \$.57 to \$2.68. These differences were made in order to secure the number of steers desired and keep the lot even. At a uniform price there was a small profit from all the steers but one.

Had the two steers Lineback and Yellow been sold as all the others were, except Longhorns, when prepared for the block, the profit would have been augmented by 11 pounds more weight of Yellow at $3\frac{1}{2}$ cents per pound 38.5 cents, and the cost of 20 days feed for each steer, or Lineback \$1.66 and Yellow $\$385 + 1.484 = \1.87 .

It will be remembered that three of the steers were regarded as fit for beef, and held at the beef price by the butcher from whom they were purchased. Even at the advanced price paid for them, the gain practically paid for over 100 days feeding except in case of one so-called "poor feeder" which was by far the poorest steer of the lot.

How many farmers realize as much, as we paid for these steers, on the stock they sell? And how many but can themselves supply these cheap foods, or raise food and fit their stock as well as was done in this test and draw a full beef price for it when sold?

D. POINTS OF INTEREST IN CONNECTION WITH THESE EXPERIMENTS.

1. WHAT CONSTITUTES A GOOD, OR A POOR FEEDER?

We commonly speak of an animal of strong build and constitution as a good feeder that eats its food with a relish and eats enough more than is needed for its support to lay on flesh, produce milk or do other work. A poor feeder is one which does not make such good use of its food, either from inability to consume enough or to properly digest what it does eat.

In the steer Longhorns one finds an example of a poor feeder. On page 10, in giving a very brief description of these steers, this steer was compared to his mate Broad thus: "One was of a stout blocky build, and was rather lighter than his mate, which was tall and rather thin." That is, one steer was built after the "beef type," and the other was not.

Now turning to the table of food consumed by each steer calculated out carefully to the digestible compounds per 1,000 pounds of live weight, it will be seen that in the second period of twenty days, when the ration consumed by Longhorns was first presented, that although originally much the larger steer he was reduced by sickness in the previous period to an average for this period of 913 pounds, while Broad had advanced to 979 pounds. But Longhorns was heavier than any of the other steers. He ate less hulls than any other tied-up steer and less per 1,000 pounds live weight of each digestible constituent. At the same time being heavier more

was required to support him, and much less could be used in gain. Following this observation down through each period in succession, in the third he ate more than some of the smaller steers of both hulls and meal. When calculated per 1,000 pounds in the following part of the table, beginning with total dry matter his ration is seen to be the smallest one of all, while most is regularly required to support the greater weight. The same is true for the fourth period. In the fifth and sixth periods, however, his appetite seems to have improved relatively as compared to the others, though gains were lessened in the sixth period, Lineback neither increasing or diminishing, and Yellow losing eleven pounds.

This observation is in evidence as to the correctness of the opinion that this form of steer was a poor feeder, and points out the undesirable form to be avoided in breeding steers, and in buying for feeding purposes.

One point worthy of notice in tracing the record of this steer Longhorns is found in the amount of water consumed by him while average weights were being made. He was off feed and irregularly fed to try to suit a capricious appetite during the first period. In the other periods the daily consumption of water was as follows:

	2d Period. Lbs.	3d Period. Lbs.	4th Period. Lbs.	5th Period. Lbs.	6th Period. Lbs.
Average of 3 steers tied with Longhorns	52.8	41.7	53.89	47.66	48.00
Longhorns	69.8	58.	59.31	58.69	69.3
Difference—more consumed by Longhorns	17.	16.3	5.42	11.03	21.3

What might have been the result of allowing this steer only the average amount of water consumed by the others?

2. ON THE TIME AND AMOUNT OF WATER DRANK, AND ITS INFLUENCE ON THE APPARENT LIVE WEIGHT.

Everyone who begins to weigh animals will find himself surprised at the fluctuations from day to day. These are so large and irregular that scarcely anyone, after a little experience, will venture to trust single weights, but will weigh each animal engaged in an experiment several times, and take the average of the weights as the weight on which to base gains or losses, and on which to make calculations. Without this precaution, discussions of changes of weight in feeding experiments would have little relevance to the actual physiological changes in the animal, and would deserve to carry little weight to the reader.

If feeding is regular and thirst is regularly appeased, it might be supposed that animals would drink with considerable regularity. They doubtless do so, but there is still variation enough to mislead in the interpretation of results, or in longer periods with a low rate of gain or loss.

These variations are no doubt most often chargeable to changes in amount of water taken at some recent draught, but may also be considerably affected by the irregularity in time and quantity consumed the previous day or two, by the amount of food taken, as well as by recent evacuations from intestine or bladder. The humidity and temperature of the air also has some effect.

The character of the food which the animal consumes at any given time, has great influence on the amount of water drank. With a succulent diet carrying a high percentage of water in its composition, there will be little or no thirst for water, while on a diet of very dry food, large draughts of water are taken at frequent intervals. Thus it seems as if the animal system, when under normal conditions, is able to keep its ingesta in about the same semi-fluid condition while consuming food of very varied character and condition as to water content.

Under normal conditions and in like seasons we should expect the same organism to require and use, if freely at hand, nearly the same total amount of water for like periods, and for different animals, on the same food, quite a correspondence in this particular over a number of days for like live weight. With such correspondence occurring over say ten-day period, there will be greater or less differences between days and parts of days which affect the live weights taken much according to the time between the ingestion or evacuation of water and the time of weighing. These differences should be least early in the morning, before the animals have taken food or water or much exercise, and for this reason all our animal weights are taken before the morning feeding. Even at this distance in time from the evening feeding, the weights are plainly varied by the amount of water taken the previous day, more by a large drink at the evening than at the morning feed, and also by refusal to drink, especially the evening before weighing.

To illustrate some of the variations which occur, the following records are given of the water drank by two steers in the experiment reported above during the days for which weights were taken to make the average live weights of the animals for each period.

TABLE IX.—WATER DRANK BY STEERS BROAD AND LONGHORNS ON DAYS PREVIOUS TO WEIGHING, FOR AVERAGE LIVE WEIGHT AT END OF EACH PERIOD.

DATE.	BROAD—LOOSE STEER.				LONGHORNS—TIED-UP STEER.			
	WATER DRANK.		Weight Fasting.	Average Weight.	WATER DRANK.		Weight Fasting.	Average Weight.
	A. M.	P. M.			A. M.	P. M.		
	Lbs. Oz.	Lbs. Oz.	Lbs.	Lbs.	Lbs. Oz.	Lbs. Oz.	Lbs.	Lbs.
Oct. 31	8 00	82 8	---	---	00 00	49 00	---	---
Nov. 1	0 00	68 00	980	---	11 00	27 8	898	---
2	0 00	65 00	965	---	20 8	00 00	886	---
3	-- --	-- --	981	975	-- --	-- --	895	893
Nov. 20	-- --	30 00	---	---	-- --	35 00	---	---
21	5 00	68 00	1000	---	39 00	36 00	913	---
22	0 8	47 00	1015	---	24 8	35 15	934	---
23	0 0	79 --	1000	---	39 00	35 00	922	---
24	-- --	-- --	1033	1016	-- --	-- --	943	933
Dec. 10	N't t'k'n	30 00	---	---	N't t'k'n	65 00	---	---
11	0 00	50 00	1060	---	00 00	47 00	981	---
12	0 00	62 00	1057	---	00 00	62 00	974	---
13	-- --	-- 00	1076	1064	-- --	-- --	982	979
Dec. 31	00 00	46 00	---	---	18 00	36 00	---	---
1892.								
Jan. 1	00 00	50 00	1071	---	00 00	68 00	997	---
2	00 00	53 00	1071	---	00 00	56 00	987	---
3	-- --	-- --	1085	1076	-- --	-- --	993	992
Jan. 19	00 00	61 00	---	---	-- --	62 00	---	---
20		35 00	1104	---	0 00	52 00	1025	---
21	00 00	55 00	1102	---	0 00	70 00	1016	---
22	00 00	46 00	1107	1110	0 00	54 00	1028	1023
23	-- --	-- --	1121	---	-- --	-- --	1026	---
Feb. 8	-- --	65 00	---	---	-- --	59 00	---	---
9	0 00	45 00	1128	---	21 00	52 00	1036	---
10	0 00	58 00	1125	---	27 8	41 00	1035	---
11	17 00	30 1	1135	1137	32 00	35 00	1031	1031
12	-- --	-- --	1151	---	-- --	-- --	1028	---

The record of the steer Broad shows an increase of weight after heavy draughts of water in each period, but in the first and third periods and last weight of the fourth, there is an increase in the live weight not accounted for by any data secured, though we could suggest a probable reason for it in the retention on these mornings of excretions usually voided before being weighed. There is also a noticeable gain in Longhorn's record seemingly too great to be thus accounted for, in the fourth period, where an increase of six pounds in weight follows immediately after a decrease of 12 pounds of water about 14 hours before being weighed.

The following table shows great variation between amounts of water consumed from day to day by any one steer, or between any of the steers on one day; yet, in the short time given—only three

days—the correspondence between total amount of water drank by steers of like weights and ages is noteworthy.

TABLE X.—TOTAL WATER DRANK BY STEERS DURING THREE DAYS WHILE AVERAGE LIVE WEIGHTS WERE BEING TAKEN.
(Weights are in pounds and ounces.)

DATE.	End of 20-day Period			BROAD.		LONGHORNS.		WHITEFACE.		BRINDLE.	
				A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.
Nov. 3..	1	Total.....		8.00	215.8	31.8	76.8	30.00	65.00	6.00	56.8
		Av. per day		74.58		36.00		31.11		20.13	
Nov. 23.	2	Total.....		5.8	195.00	102.8	106.15	28.00	124.8	62.00	30.14
		Av. per day		66.5		69.13		50.13		30.15	
Dec. 13..	3	Total.....		1.00	142.00	00.00	174.00	0.00	145.00	28.6	126.0
		Av. per day		47.11		58.00		48.5		51.7	
Jan. 2..	4	Total.....		00.00	149.00	18.00	160.00	0.00	155.00	0.00	100.00
		Av. per day		49.11		59.5		51.11		33.5	
Jan. 22..	5	Total.....		00.00	136.00	0.00	176.00	0.00	141.00	34.00	88.00
		Av. per day		45.5		58.11		47.00		40.11	
Feb. 11..	6	Total.....		17.00	133.00	80.8	128.00	1.00	140.00	64.00	82.00
		Av. per day		50.00		69.5		47.00		48.11	

		LINEBACK.		ROAN.		YELLOW.		RED EARS.	
		A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.
Nov. 3..	1	Total.....	0.00 112.8	74.8	102.8	48.00	116.8	3.8	106.8
		Av. per day	37.8	59.00		54.13		36.11	
Nov. 23.	2	Total.....	47.8 111.3	66.00	71.00	19.00	145.8	20.00	88.9
		Av. per day	52.12	45.11		54.13		36.3	
Dec. 13..	3	Total.....	26.00 120.00	38.00	100.00	0.00	114.00	58.00	99.00
		Av. per day	48.11	46.00		38.00		52.5	
Jan. 2..	4	Total.....	2.00 161.00	54.00	78.00	38.00	129.00	0.00	117.00
		Av. per day	54.5	44.00		55.11		39.00	
Jan. 22..	5	Total.....	0.00 157.00	14.00	117.00	24.00	107.00	0.00	101.00
		Av. per day	52.5	43.11		43.11		33.11	
Feb. 11..	6	Total.....	42.00 121.00	58.8	98.00	0.00	128.00	29.00	99.00
		Av. per day	54.5	52.3		42.11		42.11	

3. NOTES ON THE AMOUNT OF WATER REQUIRED BY THE ANIMALS ON DIFFERENT FOODS.

In Bulletin 81 of this Station a table was given on page 20, showing food consumed and water drank by four oxen, while average live weights were being taken in the same way as the average live weights given in this bulletin were obtained. The data for calculating water contents of food used in the experiments reported in Bulletin 81, was not so reliable as that on which this bulletin is based, hence while those could only be stated in terms of "food and water," these are based on definite analyses of the foods used.

If it be assumed that for the three days of each period on which the water was weighed to the steers, they ate the average amount for that period, and that the weight of water for the time weighed was the average drank for the period, the data is at hand to show, approximately, how much water was required to help digest the cotton-seed hulls and meal eaten by each steer, or how much water was required to digest very dry food. Later, in the finishing of three steers, corn silage was fed for ten days, and for that short time a comparison is afforded between the water required for dry food as above, and that taken with silage containing 72.67 per cent. of water.

It may be noted in the accompanying table that for every pound of dry matter of the food eaten by the loose steers, there was required (these steers were offered water freely twice per day, and it is to be supposed they drank all their systems craved) from 3.66 pounds of water in food and water drank during the three days at the end of the first period (column 7 of the table) to 2.14 for the fifth, and 1.93 pounds for the sixth period, while for the steers tied up the largest amount of water, 3.04 pounds, was at the end of the second period, and the least amount of water, 2.23 pounds, was taken at the end of the first period. It appears that while the range in amount of water drank was widest with the loose steers during the six periods of 20 days each, when these calculations were for four steers in each lot except the first, in which were only three steers, yet there was more water consumed by the steers tied up per pound of dry matter in food by 20 pounds daily, or equal to about $4\frac{1}{2}$ pounds of water per day and steer. Stating this in total average amounts of water and dry matter, there would be the following amounts consumed by 1,000 pounds live weight:

TABLE XI.—DRY FOOD AND WATER CONSUMED PER 1000 POUNDS LIVE WEIGHT.

	TIED STEERS.	LOOSE STEERS.
	Pounds.	Pounds.
Dry matter consumed daily.....	21.286	21.117
Water drank, and in food daily.....	58.32	53.848
Total av. consumption of dry food and water.....	79.606	74.965
Pounds water to one pound dry food.....	2.74	2.55

After the six periods were finished, three steers were fed through two periods of ten days. In the first the ration of cotton seed hulls and meal was continued in the proportion of 5 to 1, while silage was fed instead of the hulls during the second ten-day period. The water was weighed for only two days in the first ten-day period, and for six days for the second. Of the three steers here concerned two were tied up and one was loose. Following the silage period of ten days two steers were continued fourteen and fifteen days on hulls and meal and the water weighed every day. Referring to the table we find the loose steers had consumed .155 pounds more of water per

pound of dry matter, while being fed on silage, than the average of the whole number for the six periods on hulls and meals. This would be about 6 per cent. more water passing through the system in proportion to the dry matter than when cotton-seed hulls were fed. The total quantity, however, is less than the average while feeding on cotton-seed hulls by double this difference, which seems small when it is compared with the range of ratios found in column 7 of the table from which the average was made. The steers tied up gave a wider ratio of water to dry matter when fed on silage than the average when fed on cotton-seed hulls and the same amount of meal, but the variation was the same way in the preceding period when but two weights were taken, and again in the last one when weights were made every day and cotton-seed hulls were being fed. This wider ratio with these steers thus seems due mainly to individuality, some requiring and taking more water in proportion than others that did not like the silage so well as Brindle, the loose steer. This difference, in appetite and silage eaten, also affected the live weight as appears in Table XII, page 40.

Each of the three steers gained during the first ten-day period when hulls and meal were fed in the proportion of 5 to 1. The consumption was at the rate of 3.82 of hulls to 1 of meal for the loose steer, and 4.24 and 7.70 for the tied-up steers. The loose steer Brindle gained but two pounds, while the gain for the others was: for Whiteface 21, and Longhorns 26 pounds.

On the ration of silage they were fed the same amount of cotton-seed meal as with hulls and silage practically *ad libitum*. The ratio of silage to meal eaten was Brindle 10.1 to 1, Longhorns 9.68 to 1, and Whiteface 7.14 to 1. On this ration Brindle gained 7 pounds in 10 days, while the other two fell off 40 and 22 pounds respectively. Longhorns ate almost as much of silage (1.17 pounds less) as Brindle, and had one-fourth pound more meal, yet lost three times what the other gained. Whiteface did not eat the silage well and apparently made a heavy loss, though when dry matter and water are combined and compared, it is more than likely this was a loss in stomach contents, for during the next 15 days he advanced 63 pounds. Longhorns more than recovered the lost weight in 7 days on cotton-seed hulls and meal, but that time for him was not included in the table. Brindle gained 39 pounds in 14 days on cotton-seed hulls and meal after the silage period.

It is noticeable that the steer Brindle gained on silage, having eaten of it with more seeming relish than the others. He consumed, as shown below, scarcely more water per pound of dry matter of food, than did steers on cotton-seed hulls and meal.

Whiteface and Longhorns, however, lost weight, and we must consider this largely if not altogether due to diminution of stomach contents, since the daily food eaten contained nearly seven pounds less of dry matter than in the previous period, while the average water consumed was 9.56 pounds less than in the former period. It

appears from the table that these steers must have consumed more than the average amount of water during the days on which weights were taken immediately preceding the silage feeding, and that the gains shown were largely of extra water. This extra water was lost before the silage feeding was completed, and there was a further loss in stomach contents arising from the animals not relishing the silage as did the loose steer. These irregularities in consumption of water in the first and of food in the second 10-day period invalidate any conclusions which might be drawn. The fact that with these steers the ratio of water to dry food during the silage feeding was higher than for the average on cotton-seed hulls may simply follow from the irregular eating, or may be due to individuality, since in all the averages, including these steers, the ratio of water is higher than with the loose steers. It also is worthy of note that these steers have been the ones making slowest gains and regarded as poor feeders. This may perhaps find explanation in this larger amount of water consumed and warmed in the system.

If the ratio of water to dry food is not considered unduly raised, in the average for steers tied up, by the individuality of one pair of those steers, it appears from Table XII that 2.55 to 2.74 pounds of water to one pound of dry matter is sufficient for fattening animals; further, that as the record of one group of steers is plainly raised to some extent by the individuality of some members of the group the nearest approach to a normal ratio may be the record of the other group, 2.55 to 1.

TABLE XII.—WATER CONSUMED PER DAY AND 1000 POUNDS WEIGHT.

NUMBER OF 20-DAY PERIOD	NAME OF STEERS.	Daily Average for Loose Steers.				Pounds Water for 1 of Dry Matter.	Daily Average for Tied-up Steers.				Pounds Water for 1 of Dry Matter.
		Total Dry Mat- ter per 1000 lbs Live Weight.	Water in Food.	Water Drank.	Total Water.		Total Dry Matter.	Water in Food.	Water Drank.	Total Water.	
One	Three steers each lot	21.016	3.121	68.763	76.884	3.66	20.605	3.08	53.04	56.120	2.23
Two	Four steers each lot	21.980	3.312	53.438	56.750	2.56	23.360	3.459	67.752	71.211	3.04
Three	Four steers each lot	22.377	3.442	55.648	59.190	2.66	20.935	3.163	54.092	57.255	2.73
Four	Four steers each lot	20.923	3.262	45.011	48.273	2.37	21.191	3.307	59.537	62.844	2.92
Five	Four steers each lot	20.726	3.230	42.292	45.522	2.14	21.077	3.042	53.174	56.216	2.67
Six	Four steers each lot	19.679	3.010	35.890	38.900	1.93	20.551	3.158	55.352	58.510	2.84
Ten days	Three steers (1 loose, 2 tied)	21.666	3.283	53.922*	57.205	2.64	22.613	3.431	63.839*	67.270	2.97
Ten days	Three steers (1 loose, 2 tied), silage	17.839	32.586	15.676†	48.264	2.705	15.668	29.952	27.763†	57.715	3.68
14 and 15 days	Two steers (1 loose, 1 tied)	21.814 (Hulls)	3.325	51.941†	55.266	2.53	19.884	3.018	56.755	59.773	3.006
Average of six first periods		21.117			54.25	2.55	21.286			60.36	2.74

* Water weighed only two days, by mistake of feeder.

† Water weighed six days. ‡ Water weighed whole period.

II. CORN SILAGE AND SOY (SOJA) BEAN SILAGE WITH COTTON-SEED MEAL FOR BEEF.

Three steers and a heifer were purchased of Mr. A. T. Lambeth, Lockville, Chatham County. They were grade Jerseys. These were fed silage and cotton-seed meal, and used in digestion work, after well on the ration.

The first digestion experiment* was on corn silage and cotton-seed meal, fed at the rate of 8 pounds silage to 1 of meal, and feeding up to just about the limit of the animal's appetite. It was found, as a means of the digestion of both steers Nos. 1 and 2, that the albuminoids and carbohydrates in the rations were digested in the ratio of 1 to 4.98. This is a good proportion, though not agreeing with the standard for a first period, being rather too narrow.

The effect in growth or fattening of these steers was as follows, using a single weight, the last one: Steer No. 1 ate 1402 pounds silage and 169.13 pounds meal in 32 days and gained 78 pounds. Steer No. 2 ate 1239 pounds silage and 171.13 pounds meal. He gained during the same time 85.5 pounds.

The ration of these steers was then changed to soy bean silage, and they were fed 33 days longer for No. 1 and 36 days for No. 2. No. 1 ate 1422 pounds silage and 184.5 pounds of meal. He gained 60 pounds in that time. This gain of weight for steer No. 1 in both periods was from 739 February 10th, at the beginning in midwinter, to 877 (a single weight only) on April 16th. Steer No. 2 fed 36 days to April 6th ate 1306 pounds soy bean silage and 195.75 cotton-seed meal. His gain was for 36 days 51 pounds, and for the whole 68 days 136½ pounds. The gain per day for No. 1 was 2.123 pounds and actual live weight; while No. 2 gained 2.01 pounds per day during the whole time.

The first ration had a most excellent effect and the second continued the gain at a rate but little slower.

There has been shown such a difference between these rations that it seems worth while to examine them further.

The addition of a nitrogenous bye fodder to a coarse food rich in carbon compounds has been shown (Tech. Bul. 87d, pp. 31—32 and 42—43) to increase the digestibility of the coarse food much more than the digestibility of the protein was retarded. In the second period, the addition of nitrogenous bye fodder, cotton-seed meal, to nitrogenous coarse fodder, soy (soja) bean silage, while it may have helped on the digestion of some more of the crude fibre than would otherwise have been digested, yet fell so far short of that economic

*Bulletin 87d, No. 9.

part of its effect performed in period one, that the digestible substance of that period exceeds the digestible substance in the second period by more than four times the difference between the dry matter fed for either steer in the two periods. *That is, with a difference of only .7 pound in dry matter eaten by steer No. 1 in the two periods there were over 3 pounds more food digested in the ration of carbonaceous coarse fodder supplemented by nitrogenous bye fodder, than where nitrogenous bye fodder was added to a coarse fodder already rich in digestible nitrogenous compounds.* This latter is undoubtedly wasteful feeding, and should be carefully avoided by every thoughtful feeder.

TABLE XIII.—SHOWING COMPARISON OF SILAGE RATIONS WITH GERMAN STANDARD.

	Fresh Weight of Food.	Total Dry Matter Fed.	DIGESTIBLE FOOD PER 1000 LBS. LIVE WEIGHT.				
			Protein.	Carbo-hydrate.	Fat.	Nutritive Substance	Ratio 1:—
1st period,* steer No. 1, Silage ...	43.8	16.863	2.797	11.271	.898	14.966	4.83
C. S. meal	5.5						
1st period, steer No. 2, Silage ..	38.7	15.371	3.405	12.931	1.084	17.420	4.59
C. S. meal	5.38						
German Standard, 1st period....		27.00	2.50	15.00	.50	18.00	6.50
2d period,† steer No. 1, S. B. silage	43.1	16.161	3.806	6.044	1.894	11.744	2.83
C. S. meal	5.5						
2d period, steer No. 2, S. B. silage	36.3	14.406	4.44	6.640	2.20	13.28	2.73
C S. meal.	5.5						
German Standard, 2d period ...		26.00	3.00	14.80	0.70	18.50	5.5

* Coefficients of digestibility for first period were calculated from an experiment in digestion within this period.

† Coefficients of digestibility taken from Experiment 4, Technical Bulletin 87d, North Carolina Experiment Station, for silage; and Bulletin 3, Wisconsin Experiment Station, for cotton-seed meal.

III. EXCLUSIVE ENSILAGE FEEDING, AND WHAT IS A MAINTENANCE RATION.

Several trials of exclusive ensilage feeding have been made elsewhere, one of which fell under the observation of the writer. While the animal fed literally held its own in live weight, it was apparently due to a gain in weight of stomach contents, and the animal appeared to have lost flesh.

In discussing the building of silos and curing corn fodder in them, we have recommended that some bye fodder rich in protein or that clover hay should be fed with corn silage. Some article rich in protein should be used to narrow the nutritive ratio, in order to get the most good out of the silage, and to assure profitable feeding.

The endeavor has been to make a fair presentation of the case, so that if anyone chose to put the recommendations into practice, he, with ordinary care, would find the system all he had been led to expect, and had been advised in his own interest and not blindly in advocacy of a new imperfectly tried system.

One argument used against this plan of feeding, with more or less effect, has been in substance this: "We have been accustomed to remove the corn from the stalks, and to *feed the corn-stalks (stover) and part of the corn to fatten our animals*; while now, with a silo, you propose to put in all the corn and stalks, and, *feeding the whole*, we must, as you say, feed grain with it." The fallacy is apparent, because in the former case there was much waste of food, while with the latter a well-balanced ration is produced. The farmers who made the objection saw clearer the expenditure of cash for a bye fodder than they did the loss of food material wasted for lack of it.

In speaking of silage, most commonly silage of corn or maize is considered, but there are a number of other crops which can be made into silage equally as well as corn. Consequently we must consider the value of each kind of silage as varying from that of corn silage, according to the character of the crop from which the silage was made. Therefore the silage made from a leguminous crop, as clover, would have a larger proportion of protein than would corn, or any other representative of the grass family. It may be possible to combine the crops made into silage so as to make a perfectly balanced ration for attaining different ends in feeding. The silage may then be fed with no necessity of any additions to secure economy of production from its use.

Recently while feeding a young but full grown Jersey bull for maintenance at low cost, and with the intention of turning him to

the butcher after a long period, an opportunity came of bringing somewhat more definite data to bear on an exclusive silage feeding, and also of comparing a result with feeding silage and the standard for maintenance. It is not complete. We now regret that we did not bestow upon this feeding the same care as was given the digestion and fattening experiments, and that we did not weigh the water drank as frequently as in those experiments. The weight of the bull at the beginning and close were ascertained accurately, as also the amount of food offered and waste taken away whenever any was left, which was the case at wide intervals. The waste deducted from food offered is given in the table as the amount consumed. This feeding began on the evening of February 27th, and for the three following days two pounds of cotton-seed meal and twenty pounds of ensilage per day were fed. On March 2d, forty-five pounds of corn ensilage was fed (and one pound of cotton-seed meal by mistake of the stableman). March 3d to 13th, inclusive, 45 pounds of corn silage was fed, and up to the 13th there was no waste except 3 pounds on the 6th, and 6 pounds on the latter date.

March 14th to April 28th inclusive, 45 pounds of soy (soja) bean silage were fed. Only from 9 to 40 ounces of the morning and noon

TABLE XIV.—RATIONS FED BULL (HAYWARD), FEB., MARCH AND APRIL, 1892.

No. of Days.	KIND AND AMOUNT OF FORAGE. Lbs.	Total Dry Matter Fed. Lbs.	DIGESTIBLE.					Nutritive Substance. Lbs.	Ratio. 1:—
			Ash.	Dry Matter.	Protein.	Carbo- hydrates.	Fat.		
			Lbs.	Lbs.	Lbs.	Lbs.	Lbs.		
43	Corn silage, 113	30.883	.346	16.43	.796	12.864	.533		
	Cotton-seed meal, 9	8.306	-----	6.77	3.026	1.927	.997		
	Total fed and consumed ..	39.189	-----	23.20	3.822	14.791	1.530		
	Average daily food	9.044		5.354	.882	3.413	.353	4.648	4.87
11	Corn silage, 486.5	132.96	1.49	70.737	3.425	55.383	2.296		17.8
	Daily food	12.09	.135	6.431	.311	5.035	.209	5.555	
46	Soy bean silage, 2061.3.	531.815	33.228	313.73	63.282	184.28	33.104		
	Daily food	11.561	.722	6.82	1.375	4.006	.72	6.101	4.22
	Total food Feb. 27, P. M., to April 28	704.665	35.064	407.667	70.529	254.454	36.93		
	Average daily food for av. weight of about 900 lbs.	11.48		6.646	1.15	4.148	.602	5.9	4.91
	Average daily food for av. weight of 1000 lbs	12.63		7.311	1.265	4.563	.662	6.49	
	Standard for maintenance 1000 lbs	17.5			.70	8.00	.15	8.85	12.

NOTE.—The calculation of digestibility of cotton-seed meal was based on Armsby's determination of its digestibility (Bulletin 3, Wisconsin Experiment Station). The composition of cotton-seed meal was taken from North Carolina Experiment Station Bulletin No. 87d, Table XV. The composition of corn silage is from Table XIII, and the coefficients of digestibility are from experiment No. 5, *ibid.* The composition and digestibility of soy bean silage are from the digestion experiment on that fodder (Bulletin 87d, experiment No. 4).

feeds were refused for three days, in all 99 ounces. April 23d 10 ounces, and 26th 30 ounces were refused. This shows the silage to have been palatable to the animal and also of good quality, or there must have been more waste.

During the time corn silage was being fed, a digestion experiment of corn silage from the same lot fed here was in progress with another animal, and a similar experiment was made from the soy (soja) bean silage. We have therefore direct determinations of digestibility of both articles of food taken just as fed this bull.

The preceding table contains the calculated amounts of total dry matter, and of digestible nutrients consumed during each of the above periods, with average food per day during the last two periods, and for the average weight, the same raised for 1,000 pounds, and the "standard ration" for maintenance.

It will be noted that both protein and fat were fed in excess of the amount for the standard, while carbohydrates were scarcely more than half what the standard called for in the last period—the one we must look to for the real effect of the feeding. In the first period protein and fat were in excess owing to the cotton-seed meal fed to attract the animal, which had probably never smelled ensilage before. The second period shows low protein and carbohydrate, with high fat, and a ratio wider than the standard, while the ratio in the other periods was very narrow.

At no time was the nutritive substance quite three-fourths of what the standard requires for maintenance. It was noted that little water was needed above that in the food, and for days together it was refused.

Result.—On the morning of February 28th the fasted live weight was 836 pounds, with only one day's weight being taken. At the end the weight was 957 pounds, an average of three weights taken April 27th, 28th, 29th. There was a gain of 121 pounds, or 1.97 pounds per day. Even making great allowance for a possible error due to only one weighing at first, the gain must have been between 1.75 and 1.97 pounds per day. This seems to be a remarkable gain for the food consumed. We are inclined to ascribe the very favorable result to two or three causes: The character of the food from the silo; a great reduction of internal work from little water being required to moisten the food and carry forward the processes of digestion; and to the equable temperature and comfortable condition maintained in the stable during the whole of this feeding.

Dr. H. P. Armsby has discussed* the influences most potent in regulating demands on food for internal work and feeding for maintenance, and has pointed out the great influence exerted by the temperature of the stable, and by that of the water drank. Loss of efficiency of food from low temperature was reduced to a minimum in this experiment by favorable temperate weather, very little or no water drank, the silage being fed at a temperature little below that of the body, and a very comfortable physical condition. This result

*Manual of Cattle Feeding, chap. VIII., Sec. 3 and Part II, chap. II., sec. 1.

shows the standard to be high for animals kept under favorable conditions when three-fourths of the standard for maintenance is sufficient to produce fairly rapid fattening.

If other trials confirm the result here given, it may be stated that exclusive ensilage feeding can be practiced with success in growing and fattening stock as well as in maintenance if the ration is made so as to be fed in a properly balanced condition. Corn silage by itself must still be fed with some other food rich in protein or the corn must be grown with, or at least mixed with, pea vines or beans, and the two crops cut together, for ensilage, which will not require the purchase and addition of bye fodders.

